

WE CLAIM:

1. A cloned bacterial organophosphorus acid anhydase gene fragment comprising the DNA coding sequence:

5'

CTSCAGCCCTGACTCGGACCACTCTCTGCAAGCAGAGTCTTAAGCAATCCCAAGGGGGCCAGC
ATG CAA ACC AGA AGG GTT GTG CTC TAG TCT GCG GCC GCA GGA ACT CTC CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gln thr leu leu gly
GGC CTC GGT GCG TGC GCG ACC TGG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr thr leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TCG CGT GGT TCG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala thr pro glu phe phe gly
AGC CGC AAA GGT CTA GCG GAA AAG GGT GTG AGA GGA TTC CGC GCG AGA GCG GGT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACC ATT GTC GAT GTC TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TCG GCC GAG GTT TCG CGG GGT GCG GAC ATT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TCG TTC GAC CGC CCA GTT TCG ATG GCA TTC AGG TAT GTA GAG GAA CTC ACA
leu thr phe asp pro pro leu ser met arg leu arg tyr val glu glu thr
CAG TTC TTC CTC CGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTC CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG CGG GCG AGC TTC GCG ACC GGT GTT CGC GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACC GCA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CCA TTC TTC AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA CGC GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC CTC CGC GCA TAC CTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TCG CAA ACA CGC GGT CTC TTC ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser thr gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA GAA ATC CTC GTT TCG AAT GAC TGG CTC TTC GCG TTC TCG AGC TAT GTC
met lys gln ile leu val ser asn asp thr leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GGG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCC CAC AGG AAA CGC TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCCGCGCGGCTCTGTGTGTCACCGACTTGGCGTGCATGACGCCCATCTGGATCCTTCCACCGCAGCGCGC
ACTATTCCCGCTCAAGATACCGAAGCATGAAGTCCCGCATCGATCGATAGGCATCTTCAATGTGATCAGGG
CTCCACCTTCAAAGCCGGTGGCCACCCCTGTTCGATAGTCTTGGAGGACGGTAGCGACCGCTGCTTTTC
GTGAACTGACG
3'

2. The gene fragment of claim 1 wherein said fragment is substantially free of extraneous DNA.

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3. The gene fragment of claim 1 where the DNA is plasmid DNA.

10 4. The gene fragment of claim 1 where the source of the DNA is bacteria of the genus Flavobacterium.

15 5. The gene fragment of claim 1 where the source of the DNA is bacteria of the genus Pseudomonas.

6. An expression vector for producing bacterial organophosphorous acid anhydrase, said vector comprising a cloned bacterial organophosphorus acid anhydrase gene fragment having the DNA coding sequence:

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5'
CTGCAGCCTGACTCGGACCACTCGGTCGCAAGCAGAGTCCTAAGCAATCCGAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTC CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GCG CTC GCT GCG TCG GCG ACG TCG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA GGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TCG GCG AGC TCG GCA GGA TTC TCG CGT GGT TCG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC GCG AAA GCT CTA GCG GAA AAG GCT GTG AGA GGA TTC GCG GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GCG CTC CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT GCG GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TCG GCG GAG GTT TCG GCG GCT GCG GAC GTT CAT ATC GTG GCG GCG ACC GCG
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TCG TTC GAC GCG CCA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC CGT GAG ATT CAA GAT GCG ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GCG ATT ATC AAG GTC GCG ACC AGA GCG AAG GCG ACC GCG TTC CAG GAG TTA GTC
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG GCG GCG AGC TTC GCG ACC GGT GTT CCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG GCG GAT GGT GAG CGA GCG AGG GCG CCA TTT TTC AGT CCG
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTC GAG CCG TCA GCG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC CTC GCG GCA TAC CTC ATC GGT CTA GAC CAC ATC CCG
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CCG CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TCG CAA ACA CCG GCT CTC TTC ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TCG CTC TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CCG GTC AAC CCG GAC GCG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CGA CTC AGA GTC ATC CCA TTC TAC GAG AGA AGG GCG TCG CAC AGG AAA CCG TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCCTGGCGCGGTCTGTGTCAACCGACTTGGCTGCAATGACCGCCATCTGGATCCTTCCACGCGCGCC
ACTATTCCTCCCTCAAGATACCGAACGATGAAGTCCGCAATCGATAGGCACTCTTCAATGTGATCAGGG
CTCCCACTCTCAAAAGCCGCTGGCCACCCCTGTCTCGATAGTCTTGGGGACCGTAGCGACGACCGTCTCTTTC
GTGAAGTCAG
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7. The expression vector of claim 6 further comprising a promoter, a start codon, and a recombinant DNA sequence coding for bacterial organophosphorus acid anhydase in accurate reading frame sequence with said start codon for translation.

8. The expression vector of claim 7 wherein said vector is derived from a baculovirus.

9. The expression vector of claim 7 wherein said vector is a bacteriophage.

10. The expression vector of claim 7 wherein said vector is a plasmid.

11. The expression vector of claim 10 wherein said plasmid comprises a transposon capable of transposing the Drosophila genome.

CSM

12. A transformed microorganism comprising an expression vector for producing bacterial organophosphorus acid anhydrase wherein said vector has a cloned bacterial organophosphorus acid anhydrase gene fragment with the DNA coding sequence:

5'
CTGCAGCCTGACTCGGACCCAGTCCGCTGCAAGCAGAGTCCTAAGCAATGCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTG CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTG GGT GGG TGC GCG ACG TGG CTG GAT CSA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTG ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TTG CGT GCT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GCT CTA GCG GAA AAG GCT GTG AGA GGA TTG CGC GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC CTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TTG GCG GAG GTT TCG CGG GCT GCC GAC GTT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTG TGG TTC GAC CGC CCA CTT TCG ATG CGA TTG AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu leu thr
CAG TTC TTC CTG CGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG CTC GCG ACC ACA GCG AAG GCG ACC CGC TTT CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG CGC GCG AGC TTG GCG ACC GGT GTT CGC GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG CGC GAT GGT GAG CSA GCG AGG CGC CCA TTT TTG AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CCC TCA CGG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTG
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCC CTG CTG CGC GGA TAC CTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTG GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CGG GCT CTC TTG ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTG TTC GGG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CCC GAC GGG ATG GCC TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTG AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCC CAC AGG AAA CGC TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCCGGCGCGGTCTGTGTACCCGACTTGCCGTGCATGACGCCATCTGGATCCTTCCACGCGCGGCC
ACTATTCCCGGTCAAGATACCGAACGATGAAGTCCGCGCATCGATCGATAGGCATCTTCAATGTGATCAGGG
CTGCCACCTCCAAAGCCGGTGGCCACCCCTGTGCGATAGTCTTGAGGGACCGGTAGCCACGACCCGTGCTTTTC
GTGAACGCGAG
3'

13. The transformed microorganism of claim 12 wherein said microorganism is a bacteria.

14. A transformed eukaryotic cell line comprising an expression vector for producing bacterial organophosphorus acid anhydrase wherein said vector has a cloned bacterial organophosphorus acid anhydrase gene fragment with the DNA coding sequence:

5'
CTGCAGCCTGACTCGGCACCGAGTCGCTCGAAGCAGAGTCGTAAGCAATCGCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTC CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTC GGT GCG TGC GCG ACG TGG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GCG AGC TCG GCA GGA TTC TCG GGT GGT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC GCG AAA GCT CTA GCG GAA AAG GCT GTC AGA GGA TTC GCG GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC CTC CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT GCG GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg arg val ser
TTA TTC GCG GAG GTT TCG GCG GGT GCG GAC GTT CAT ATC CTC GCG GCG ACC GCG
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TGG TTC GAC GCG CCA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC GGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC GCG TTC CAG GAG TTA CTC
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG GCG GCG ACC TTC GCG ACC GGT GTT GCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG GCG GAT GGT GAG CGA GCG AGG GCG CCA TTC TTC AGT GCG
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CTC TCA GCG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC CTC GCG GGA TAC CTC ATC GGT CTA GAC CAC ATC GCG
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CCG CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TCG CAA ACA GCG GGT CTC TTC ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TCG CTC TTC GCG TTC TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CCG GTC AAC CCG GAC GCG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTC ATC CCA TTC TAC GAG AGA AGG GCG TCG CAC AGG AAA GCG TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCGCGCGCGGTCTGTGTCTACCGCACTTGCCTGTCATGACGCCATCTGGATCCTTCCACCGCAGCGCGC
ACTATTCCCGCTCAAGATACCGAACGATGAAGTCCCGCATCGATAGGCATCTTCAATGTGATCAGGG
CTGCGACCTTCCAAAGCGCGGTGCGCCACCGCTGTGATAGTCTTGAGGACCGGTAGCGACCGCTGCTTTTC
GTGAAGTGCAG
3'

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15. The transformed cell line of claim 14 wherein said cell line is derived from an insect. -

5 16. The transformed cell line of claim 15 wherein said insect is a Fall army worm caterpillar.

5'
CTGCAGCCTGACTGCGCCAGTCTGCTGCAAGCAGAGTCTGAAGCAATGCAAGGGGGGAGG
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTC CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTC GGT GGG TGC GCG ACG TGG CTC GAT CGA TCG GCA CAG GCG ATC CGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CST GCG CGT COT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TCG GCG AGC TCG GCA GGA TTC TTS CST GGT TGG CGA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GGT CTA GCG GAA AAG GGT GTG AGA GGA TTC CGC GCC AGA GCG GGT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC CTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TCG GCG GAG GTT TCG CCG GGT GCG GAC GTT CAT ATC GTG GCG GCG ACC GCG
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TCG TTC GAC CGC CGA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC GGT GAG ATT GAA TAT GGC ATC GAA GAC ACC CGA ATT AGG CGC
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTC CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG GCG GCG ACC TTC GCG ACC GGT GTT CCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACC CGA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CGA TTC TTC AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TTA CCG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACT GCG CTC CTC CCG GGA TAC TTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CST TCG TGG CAA ACA CCG GGT CTC TTC ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTC TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GCG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCG CAC AGG AAA CCG TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAAGCCCGGCGGTTCTGTGTGTCACCGACTTGGCGTGCATGACGCCATCTGGATCTTCCACCGAGCGGCG
ACTATTCCCGCTCAAGATACCGAAGCATGAAGTCCCGCATGATCATAGGCATCTTCAATGTGATCAGCG
CTGCGACCTCCAAAGCCCGTGGCCACCGCTGTGATAGTCTTGGAGGACCGGTAGCGACGACCGCTGCTTTTC
GTGAAGCTGACG
3'

17. A transgenic eukaryotic organism comprising an expression vector for producing bacterial organophosphorus acid anhydrase wherein said vector has a cloned bacterial organophosphorus acid anhydrase gene fragment having the
- 5 DNA coding sequence:

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5'
CTSCAGCGCTGACTCGGACCGAGTCGCTGCAAGCAGAGTCGTAAGCAATCCCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTC CTC GCG
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTC GGT GGG TGC GCG ACG TGG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TCG CGT GGT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GCT CTA GCG GAA AAG GCT GTG AGA GGA TTC CGC GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TTC GCC GAG GTT TCG CGC GCT GCC GAC GTT CAT ATC CTC GCG GCC ACC GCG
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TGG TTC GAC CGC CCA CTT TCG ATG CGA TTC AGG TAT ATA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC GGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ala glu asp thr gly ile arg ala
GGC ATT ATC AAG CTC GCG ACC ACA GCG AAG GCG ACC CGC ATT CAG GAG TTA GTC
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCC CGC CGC GCG ACC TTC GCG ACC GGT GGT CGC GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACC GCA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CCA TTT TTC AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA CGC GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAC CTC ACC GCG CTC CTC GCG GGA TAC CTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CGC GGT CTC TTC ATC AAG GCG CTC ATC CAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTC TTC GGG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GGG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCG CAC AGG AAA CGC TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCGCGCGCGGTCTGTGTCACCGAAGTTCGCGTGCATGACCGCCATCTGGATCCTTCACCGCAGCGCGC
ACTATTCGCGCGTCAAGATACCGAAGGATGAAGTCGCGCATCGATAGGCATCTTCAATGTGATCAGGG
CTGCGACCTCCAAAGCGCGGTGGCGACCCCTGTGTCATAGTCTTGGAGGACCGGTAGCGACCGACCGTGTTC
GTGAAGTCGAG
3'
```


18. A transgenic organism as claimed in claim 17 wherein
said organism is derived from microinjection of said
expression vector into Drosophila melanogaster embryo
5 cells.

Csm

19. A transgenic organism as claimed in claim 17 wherein
said organism is derived from injection of said expression
10 vector into a Fall army worm caterpillar.

20. A method for making bacterial organophosphorus acid
anhydrase, said method comprising:

15

growing in a nutrient medium a transformed
microorganism having an expression vector with a
cloned bacterial organophosphorus acid anhydrase
gene fragment having the DNA coding sequence:

20

5' CTGCAGCCTGACTCGGCACCACTGCTGCTGCAAGCAGAGTCTGTAAGCAATCGCAAGGGGGCAGC
 ATG CAA ACC AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTG CTC GGC
 met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly

5 GGC CTG GCT GGG TGC GCG AGC TGG CTG GAT GSA TCG GCA CAG GCG ATC GGA TCA
 gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser

ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTG ACT CAC GAG
 ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu

GAC ATC TGC GGC AGC TCG GCA GSA TTC TCG CGT GGT TGG CCA GAG TTC TTC GGT
 asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly

AGC CGC AAA GCT CTA GCG GAA AAG GCT GTG AGA GGA TTC CGC GCC AGA GCG GCT
 ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala

10 GGC GTG CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC CTC AGT
 gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser

TTA TTG GCG GAG GTT TCG CGG GCT GCG GAG GTT CAT ATC GTG GCG ACC GCG
 leu leu ala glu val ser arg ala ala asp val his ile val ala thr gly

TTG TGG TTC GAC CGC CCA CTT TCG ATG GSA TTC AGG TAT GTA GAG GAA CTC ACA
 leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr

CAG TTC TTC CTG CGT GAG ATT CAA TAT GCG ATC GAA GAC ACC GGA ATT AGG GCG
 gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala

15 GGC ATT ATC AAG CTC GCG ACC ACA GCG AAG GCG ACC CGC TTC CAG GAG TTA GTG
 gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val

TTA AAG GCG GCG GCG GCG GCG AGG TTG GCG ACC GGT GTT CCG GTA ACC ACT CAC
 leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his

ACC GCA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CCA TTC TTG AGT CGC
 thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro

AAG CTT GAG CGC TCA CGG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTG
 lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu

AGC TAT CTC ACC GCG CTG CTG CGC GGA TAC CTC ATC GGT CTA GAC CAC ATC CGC
 ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro

20 CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTG GCG ATC
 his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile

CGT TCG TGG CAA ACA CGG GCT CTC TTG ATC AAG GCG CTC ATC GAC CAA GCG TAC
 arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr

ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTG TTC GCG TTC TCG AGC TAT GTC
 met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val

ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GCG ATG GCG TTC ATT
 thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile

25 CCA CTG AGA GTG ATC CCA TTC TAC CAG AGA AGG GCG TCC CAC AGG AAA GCG TCG
 pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys

CAG GCA TCA CTG TGA
 gln ala ser leu
 CTAACCGCGCGCGCTTCTGTGTCACCGAATTGCGCTGCATGACCGCATCTGGATCCTTCCACGCGCGCGC
 ACTATTCCCGCTCAAGATACCGAAGCATGAAGTCGCGCATCGATCGATAGGCATCTTCAATGTGATCAGGG
 CTCCACCTCCAAAGCCCGGTGCGCCACCCCTGTGCGATAGTCTTGAGGGACCGGTAGCGACGACCGCTGCTTTC
 GTGAAGTGCAG
 3'

allowing said microorganism to produce bacterial
 organophosphorus acid anhydase; and

recovering the bacterial organophosphorus acid
 anhydase.

21. A method for making bacterial organophosphorus acid anhydrase, said method comprising:

growing in a nutrient medium a transformed eukaryotic cell line comprising an expression vector with a cloned bacterial organophosphorus acid anhydrase gene fragment having the DNA coding sequence:

5' CTGCAGCCTGACTCGGACCCAGTCCGCTSCAAGCAGAGTCGTAAGCAATCCCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG TTC AAG TCT GCG GCC GCA GGA ACT CTG CTC GGC
10 met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTG GGT GGG TGC GCG ACC TGG CTG GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTG ACT CAC GAG
15 ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TTA CGT GCT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GGT CTA GCG GAA AAG GCT GTG AGA GGA TTG CGC GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
20 GGC CTG CGA ACG ATT GTG GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TTG GCC GAG GTT TCG CGG GCT GCC GAC GTT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTG TGG TTC GAC CGC CCA GTT TCG ATG CGA TTG AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu leu thr
CAG TTC TTC CTG CGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
25 gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTT CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCC GCG GCG GCG GCG ACC TTG GCG ACC GGT GTT CGC GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CCA TTT TTG AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA CGG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTG
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
30 AGC TAT CTC ACC GCG CTG CTG GCG GGA TAC CTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTG GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CGG GCT CTC TTG ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTG TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GGG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTG AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCC CAC AGG AAA CGC TGC
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTG TGA
gln ala ser leu
CTAACCCCGCGCGGTCTCTGTGTGACCCGACTTGGCGGTGCATGACGCCATCTGGATCCTTCCACGCGCGCGC
ACTATTCGCGCGGTCAAGATACCGAAGCATGAAAGTCGCGCATCGATCGATAGGCGATCTTCAATGTGATCAGGG
CTGCGACCTCCAAAGCGCGGTGGCCACCGCTGTGATAGTCTTGGAGGCGCGGTAGCGACGACCGCTGCTTTTC
GTGAACCTGCAG
3'

allowing said microorganism to produce bacterial
organophosphorus acid anhydrase; and

recovering the bacterial organophosphorus acid
anhydrase.

5

22. A method for making bacterial organophosphorus acid anhydrase, said method comprising:

5 nourishing a transformed host in a nutrient medium
 allowing said host to produce bacterial
 organophosphorus acid anhydrase;

10 transforming host an expression vector comprising a
 DNA sequence coding for said bacterial
 organophosphorus acid anhydrase; and

15 separating the bacterial organophosphorus acid
 anhydrase from said host and said nutrient
 medium.

20 23. The method for making bacterial organophosphorus acid
 anhydrase of claim 22 further comprising purifying said
 bacterial organophosphorus acid anhydrase.

25 24. The method for making bacterial organophosphorus acid
 anhydrase of claim 22 wherein said host is a
 microorganism.

30 25. The method for making bacterial organophosphorus acid
 anhydrase of claim 24 wherein said microorganism is a
 bacteria.

35 26. The method for making bacterial organophosphorus acid
 anhydrase of claim 22 wherein said host is a eukaryotic
 cell line.

27. The method for making bacterial organophosphorus acid anhydrase of claim 26 wherein said eukaryotic cell line is derived from an insect.

5

28. The method for making bacterial organophosphorus acid anhydrase of claim 27 wherein said insect is a Fall army worm caterpillar.

10

29. The method of claim 22 wherein said anhydrase is purified to a level of approximately 3200 units/mg of anhydrase.

15

30. The cloned bacterial organophosphorus acid anhydrase gene fragment of claim 1 where in the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

20

31. The expression vector of claim 6 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

25

32. The transformed microorganism of claim 12 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

30

33. The transformed eukaryotic cell line of claim 14 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

35

34. The transgenic eukaryotic organism of claim 17 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

5

35. The method for making bacterial organophosphorus acid anhydrase of claim 20 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

10

36. The method for making bacterial organophosphorus acid anhydrase of claim 21 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

15

37. The cloned bacterial organophosphorus acid anhydrase gene fragment of claim 1 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

20

38. The expression vector of claim 6 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

25

39. The transformed microorganism of claim 12 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

30

Sub 13
40. The transformed eukaryotic cell line of claim 14 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

5
41. The transgenic eukaryotic organism of claim 17 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

10
42. The method for making bacterial organophosphorus acid anhydase of claim 20 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.

15
43. The method for making bacterial organophosphorus acid anhydase of claim 21 wherein the C-terminal sequence has been deleted from Bam HI to PstI of said DNA coding sequence.
20

44. Organophosphorus acid anhydase produced by a genetically transformed host having an expression vector
25 comprising a DNA sequence coding for said anhydase.

improp. dependent claim. no anti-estab basis for the method
45. The method of claim 44 wherein said anhydase is characterized by $K_{cat} = 2100 \text{ sec}^{-1}$ for paraoxon.
30

46. Bacterial organophosphorus acid anhydrase produced by a genetically transformed host having an expression vector comprising a cloned gene fragment with the DNA coding sequence:

5

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5'
CTGCAGCCCTGACTCGGACCCAGTCCGCTCCAGCAGAGTCCTAAGCAATCCCAAGGGGGCAGC
ATG CAA ACC AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTC CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTC GGT GGG TGC GCG ACC TGG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TCG GGT GGT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GCT CTA GCG GAA AAG GGT GTG AGA GGA TTC CGC GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACC ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TTC GCG GAG GTT TCG CGG GCT GCC GAC GTT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTG TCG TTC GAC CGC CCA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC COT GAG ATT CAA TAT GGC ATC GAA GAC ACC GCA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTT CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG CGG GCG AGC TTC GCG ACC GGT GTT CGG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACC GCA GCA AGT CAG CGC GAT GGT GAG CGA GGC AGG CGC CCA TTT TTG AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA CGG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC CTC CGC GGA TAC CTC ATC GGT CTA GAC CAC ATC CGC
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CGG GGT CTC TTG ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATC AAA CAA ATC CTC GTT TCG AAT GAC TCG CTC TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CGC GTG AAC CGC GAC GGG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCC CAC AGG AAA GCG TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAAGCCCGGCGGGTCTGTGTGTCACCGACTTGCCTGTCATGACGCCATCTGGATCCTTCCACGAGCGGGC
ACTATTCCTCCCTCAAGATACCGAACGATGAAGTCGCGCATCGATCGATAGGCATCTTCAATGTGATCAGGG
CTGCCACTTCCAAAGCCCGTGGCCACCCCTGTCTGATAGTCTTTAGGGACCGGTAGCGACGACCGTCTCTTTC
GTGAACCTGCAG
3'

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47. The bacterial organophosphorus acid anhydrase of claim 46 wherein the N-terminal sequence up to the start codon has been deleted from said DNA coding sequence.

48. The bacterial organophosphorus acid anhydrase of claim 46 wherein the C-terminal sequence up to the start codon; has been deleted from Bam HI to PstI of said DNA coding sequence.

49. The bacterial organophosphorus acid anhydrase of claim 46 wherein said host producing acid anhydrase is a microorganism.

50. The bacterial organophosphorus acid anhydrase of claim 46 wherein said host producing said anhydrase is a bacterial.

51. The bacterial organophosphorus acid anhydrase of claim 46 wherein said host is a eukaryotic cell line.

52. The bacterial organophosphorus acid anhydrase of claim 46 wherein said anhydrase is relatively pure, characterized by $K_{cat} = 2100 \text{ sec}^{-1}$ for paraoxon.

53. A method for detoxifying an organophosphorus compound comprising exposing said compound to recombinant bacterial organophosphorus acid anhydrase.

54. The method of claim 53 wherein said exposure is accomplished by passing said compound through a matrix comprising said recombinant anhydrase.

5

55. The method of claim 54 wherein said matrix is further comprised of a filtration device.

10 56. The method of claim 55 wherein said device is a gas mask.

15 57. The method of claim 53 wherein said organophosphorus compound is in air.

20 58. The method of claim 53 wherein said organophosphorus compound is in a fluid.

25 59. The method of claim 53 wherein said exposure is accomplished by spraying said recombinant anhydrase on a locus comprising the organophosphorus compound.

30 60. The method of claim 53 wherein said exposure is accomplished by introducing said anhydrase into a container comprising the organophosphorus compound.

61. The method of claim 53 wherein said recombinant bacterial organophosphorus acid anhydrase is produced by a transformed microorganism comprising an expression vector for producing said anhydrase and wherein said vector has a
5 cloned bacterial organophosphorus acid anhydrase gene fragment with the DNA coding sequence:

5'
CTGCAGCCTGACTCGGCACCACTCGCTGCAAGCAGAGTCCTAAGCAATCGCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT TCG GCC GCA GGA ACT CTS CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTC GGT GGG TGC GCG ACG TGG CTC GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC AGA ATC TCT GAA GCG GGT TTC ACA CTC ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGC GGC AGC TCG GCA GGA TTC TCG GGT GGT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GCT GTA GCG GAA AAG GGT GTG AGA GGA TCG CGC GCC AGA GCG GGT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACG ATT GTC GAT GTG TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TCG GGC GAG GTT TCG CGG GGT GGC GAC GTT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TGG TTC GAC CCG CGA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTC GGT GAG ATT CAA TAT GGC ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTT CAG GAG TTA CTC
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCG GCG CCG GGT AGC TTC GCG ACC GGT GTT CCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG CCG GAT GGT GAG CGA GCG AGG CCG CGA TTT TTC AGT CCG
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CCG TCA CCG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC CTC CCG CGA TAC CTC ATC GGT CTA GAC CAC ATC CCG
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT TTA GAA GAT AAT GCG AGT GCA TCA CCG CTC CTC GGC ATC
his ser ala ile gly leu glu asp asp ala ser ala ser pro leu leu gly ile
CST TCG TGG CAA ACA CCG GGT CTC TTC ATC AAG GCG CTC ATC GAC CAA GGC TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTC TTC GGG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CCG GTG AAC CCG GAC GGG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TTC TAC GAG AGA AGG GCG TCC CAC AGG AAA CCG TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCGGGCGCGGTCTTGTGTACCGCACTTGGCGTGCATGACGCCATCTGGATCTTCCACCGCAGCGGCC
ACTATTCGGCGTCAAGATACCGAACGATGAAGTCGCGCATCGATCGATAGGCATCTTCAATGTGATCAGGG
CTGCCACCTCCAAAGCGGTGGCCACCGCTGTGCGATAGTCTTGAGGGACGGTAGCGACCGGTGCTTTTC
GTGAACTCAG
3'

62. The method of claim 53 wherein said recombinant bacterial organophosphorus acid anhydrase is produced by a transformed eukaryotic cell line comprising an expression
5 vector for producing said anhydrase and wherein said vector has a cloned bacterial organophosphorus acid anhydrase gene fragment with the DNA coding sequence:

```
5'
CTGCAGCCTGACTCGGACCACTGCGTGCAGCAGTCTGTAAGCAATCCCAAGGGGGCAGC
ATG CAA ACG AGA AGG GTT GTG CTC AAG TCT GCG GCC GCA GGA ACT CTG CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GCC CTG GCT GCG TCC GCG AGC TGG CTG GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTG ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TGG GCG AGC TCG GCA GGA TTC TTC CGT GCT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GCT CTA GCG GAA AAG GCT GCG AGA GGA TCG CGC GCC AGA GCG GCT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GCC GTG CGA ACG ATT GTC GAT GTG TCG ACT TCG GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TCG GCC GAG GTT TCG CGG GCT GCG GAC GTT CAT ATC GTG GCG GCC ACC GCG
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TCG TTC GAC CGC CCA CTT TCG ATG CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC CTG GGT GAG ATT CAA TAT GCG ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GCC ATT ATC AAG GTG GCG ACC ACA GCG AAG GCG ACC CGC TTT CAG GAG TTA GTG
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCC GCG CGG GCG AGC TTS GCG ACC GGT GTT CCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG CGC GAT GGT GAG CGA GCG AGG CGC CCA TTT TCG AGT CCG
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA CGG GTT TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CAG CTG CCG GGA TAC CTC ATC GGT CTA GAC CAC ATC CCG
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC CTG GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CGG GCT CTC TTG ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TCG CTC TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATG GAC GTG ATG GAT CCG GTG AAC CCC GAC GCG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTG ATC CCA TCG GAG AGA AGG GCG TCC CAC AGG AAA GCG TGC
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCCGGGGCGGTTCTGTGTGTCACCGAAGTTCGGGTGCATGACGCCATCTGGATCTTCCACCGAGCGGGC
ACTATTCCGGGCTGAAGATACCGAAGCATGAAGTCCGCGCATCGATAGGCATCTTCAATGTGATCAGGG
CTGCCAGCTCCAAAGCCGGGTGGCCACCCCTGTGCGATAGTCTTGAGGGACGGTAGCGGACCGCTGCTTTTC
GTGAACGCGAG
3'
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63. The method of claim 53 wherein said recombinant bacterial organophosphorus acid anhydriase is produced by a transgenic eukaryotic organism comprising an expression vector for producing said anhydriase wherein said vector
5 has a cloned bacterial organophosphorus acid anhydriase gene fragment with the DNA coding sequence:

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5'
CTSCAGCCTGACTGGGACCAAGTCCGCTGCAAGCAGAGTCCGTAAGCAATCCGAAGGGGGCAGC
ATG CAA ACG AGA AGG GTC GTG CTC AAG TCG GCG GCC GCA GGA ACT CTG CTC GGC
met gln thr arg arg val val leu lys ser ala ala ala gly thr leu leu gly
GGC CTG GGT GGA TGC GCG ACG TCG CTG GAT CGA TCG GCA CAG GCG ATC GGA TCA
gly leu ala gly cys ala thr trp leu asp arg ser ala gln ala ile gly ser
ATA CGT GCG CGT CCT ATC ACA ATC TCT GAA GCG GGT TTC ACA CTG ACT CAC GAG
ile arg ala arg pro ile thr ile ser glu ala gly phe thr leu thr his glu
GAC ATC TCG GCG AGC TCG GCA GGA TTC TCG CGT GCT TGG CCA GAG TTC TTC GGT
asp ile cys gly ser ser ala gly phe leu arg ala trp pro glu phe phe gly
AGC CGC AAA GGT CTA GCG GAA AAG GCT GTG AGA GGA TTC CGC GCC AGA GCG GGT
ser arg lys ala leu ala glu lys ala val arg gly leu arg ala arg ala ala
GGC GTG CGA ACG ATT GTC GAT GTC TCG ACT TTC GAT ATC GGT CGC GAC GTC AGT
gly val arg thr ile val asp val ser thr phe asp ile gly arg asp val ser
TTA TTC GCC GAG GTT TCG CGG GCT GCG GAC GTT CAT ATC GTG GCG GCG ACC GGC
leu leu ala glu val ser arg ala ala asp val his ile val ala ala thr gly
TTC TCG TTC GAC GCG CCA CTT TCG ATC CGA TTC AGG TAT GTA GAG GAA CTC ACA
leu trp phe asp pro leu ser met arg leu arg tyr val glu glu leu thr
CAG TTC TTC GTC CGT GAG ATT CAA TAT GCG ATC GAA GAC ACC GGA ATT AGG GCG
gln phe phe leu arg glu ile gln tyr gly ile glu asp thr gly ile arg ala
GGC ATT ATC AAG GTC GCG ACC ACA GCG AAG GCG ACC CGC TTC CAG GAG TTA GTC
gly ile ile lys val ala thr thr gly lys ala thr pro phe gln glu leu val
TTA AAG GCG GCT GCG CGG GCG ACC TTC GCG ACC GGT GTT GCG GTA ACC ACT CAC
leu lys ala ala ala arg ala ser leu ala thr gly val pro val thr thr his
ACG GCA GCA AGT CAG CCG GAT GGT GAG CGA GCG AGG CGC CCA TTT TTC AGT CGC
thr ala ala ser gln arg asp gly glu arg gly arg pro pro phe leu ser pro
AAG CTT GAG CGC TCA GCG GTC TGT ATT GGT CAC AGC GAT GAT ACT GAC GAT TTC
lys leu glu pro ser arg val cys ile gly his ser asp asp thr asp asp leu
AGC TAT CTC ACC GCG CTC GTC GCG GGA TAC CTC ATC GGT GTA GAC CAC ATC GCG
ser tyr leu thr ala leu leu arg gly tyr leu ile gly leu asp his ile pro
CAC AGT GCG ATT GGT CTA GAA GAT AAT GCG AGT GCA TCA CGC CTC GTC GCG ATC
his ser ala ile gly leu glu asp asn ala ser ala ser pro leu leu gly ile
CGT TCG TGG CAA ACA CCG GCT CTC TTC ATC AAG GCG CTC ATC GAC CAA GCG TAC
arg ser trp gln thr arg ala leu leu ile lys ala leu ile asp gln gly tyr
ATG AAA CAA ATC CTC GTT TCG AAT GAC TGG CTC TTC GCG TTT TCG AGC TAT GTC
met lys gln ile leu val ser asn asp trp leu phe gly phe ser ser tyr val
ACC AAC ATC ATC GAC GTC ATG GAT CGC GTC AAC CGC GAC GCG ATG GCG TTC ATT
thr asn ile met asp val met asp arg val asn pro asp gly met ala phe ile
CCA CTC AGA GTC ACC CCA TTC TAC GAG AGA AGC GCG TCC CAC AGG AAA CGC TCG
pro leu arg val ile pro phe tyr glu arg arg ala ser his arg lys arg cys
CAG GCA TCA CTC TGA
gln ala ser leu
CTAACCCCGCGCGGTTCTGTGTCCACCGAATTGCGGTGCGATGACGCCCATCTGGATCCTTCCACCGCAGCGGGC
ACTATTCGCGCTCAAGATACCGAACGATGAAGTCCGCCATCGATCGATAGGCATCTTCAATGTGATCAGGG
CTGCCACCTCCAAAGCGCGGTGGCCACCCCTGTCTGATAGTCTTTCAGGGACCGGTAGCGACGACCGCTGCTTTTC
GTGAACTGCAAG
3'
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64. A method of preventing poisoning of a locus by an organophosphorus compound by applying recombinant organophosphorus acid anhydrase to said locus before said compound contacts said locus.

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65. A method of detecting bacterial colonies capable of detoxifying organophosphorus acid anhydrides, comprising employing a transformed microorganism as a control in a plate assay wherein said microorganism is comprised of an expression vector for producing organophosphorus acid anhydrase and said vector is comprised of a cloned gene fragment containing the DNA coding sequence for the anhydrase.

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66. The method of claim 65 wherein said anhydrides comprise a pesticide and said plate assay is conducted prior to applying said pesticide to soil to quantitate the number of microorganisms capable of detoxifying said pesticides in said soil.

67. A method for protecting insects from organophosphorus compounds comprising feeding said insects recombinant organophosphorus acid anhydrase.

68. A method for protecting insects from organophosphorus compounds comprising infecting insects with microorganisms comprised of an expression vector for producing an organophosphorus acid anhydrase wherein said vector is comprised of a cloned gene fragment containing the DNA coding sequence for the anhydrase.

69. A method for protecting insects from organophosphorus compounds comprising introducing into the environment of said insects microorganisms comprised of an expression vector for producing an organophosphorus acid anhydrase
5 wherein said vector is comprised of a cloned gene fragment containing the DNA coding sequence of the anhydrase.

70. A pesticide comprising an organophosphorus compound
10 and an inhibitor of bacterial organophosphorus acid anhydrase.

*add
a₄*

add E2

add E2